1/31/17 "Failing to prepare, is preparing to fail."-Anonymous

HW: "Shifting Functions" Homework section

AIM: How do we identify shifts of functions?

Warm Up:

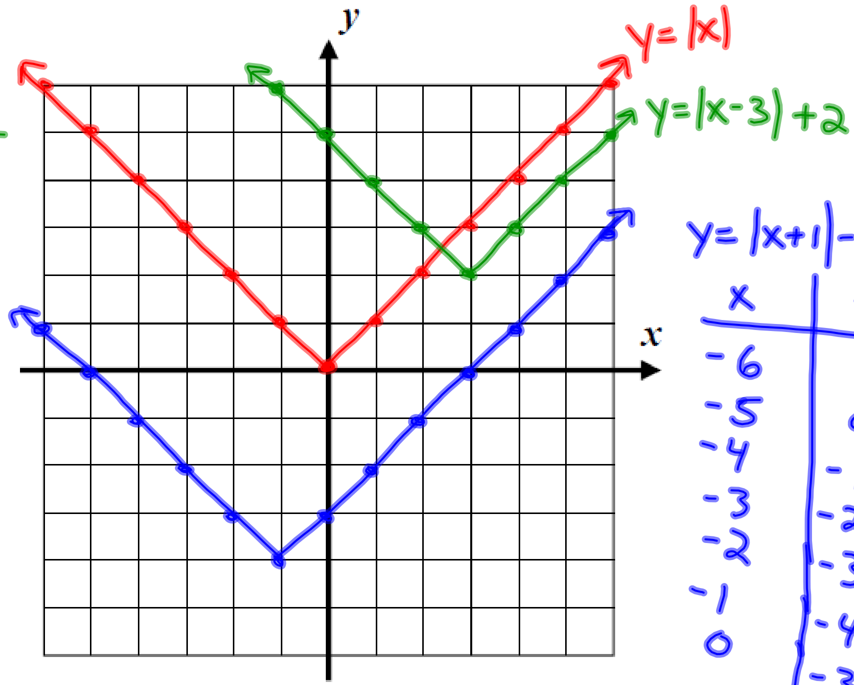
Exercise #1 part (a) on the handout

***Exercise* #1:** Consider the functions $y=|x|$, $y=|x-3|+2$, and $y=|x+1|-4$.

(a) Without the use of your calculator, graph $y=|x|$ on the axes provided. Label its equation.

$y=|x-3|+2$

x	y
-1	6
0	5
1	4
2	3
3	2
4	3



$y=|x+1|-4$

x	y
-6	1
-5	0
-4	-1
-3	-2
-2	-3
-1	-4
0	-3

(b) Using your calculator to generate a table of values, graph the other two absolute value functions above and label each with its equation.

(c) How would the graph of $y=|x|$ be shifted in order to produce the graph of $y=|x-6|-8$?

right 6 down 8

Inside : Left/Right affects x-values
$+ \quad -$

Outside: Up/Down affects y-values
$+ \quad -$

Vertical and Horizontal Shifting

up/down

1. **Vertical Shifting**: The function $f(x)+k$ shifts the function up by $|k|$ units for $k>0$ and down $|k|$ units for $k<0$.
outside function

left/right

2. **Horizontal Shifting**: The function $f(x+k)$ shifts the function left $|k|$ units for $k>0$ and right $|k|$ units for $k<0$.
inside the function

***Exercise* #2:** The function $f(x)$ is shown on the grid below. A second function, g, is defined by $g(x)=f(x-3)+1$. ← up 1, right 3

(a) What is the value of $g(0)$? Show how you arrived at your answer.

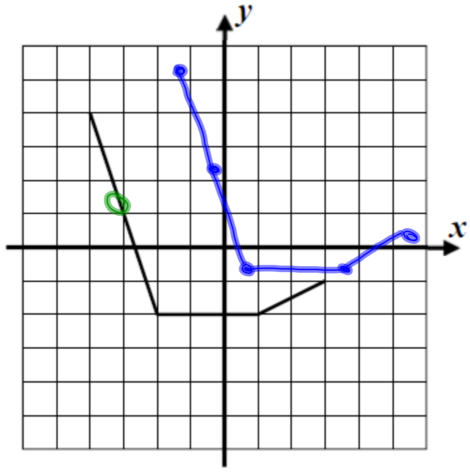
$g(x)=f(x-3)+1$

$g(0)=f(0-3)+1$

$=f(-3)+1$

$=1+1$

$g(0)=2$



(b) Identify how the graph of f has been transformed to produce the graph of g and sketch it on the grid.

Shift right 3 and up 1

We can use these shifting patterns in a variety of ways because they apply to all types of functions.

***Exercise* #3:** A function, $f(x)$, has a domain of $-3\le x\le 10$ and a range of $y\le 22$. What are the domain and range of the function $f(x+7)+10$? Explain how you arrived at your answers.

left 7
~~subtract 7~~
from x-values

up 10
~~add~~ 10 to
all y-values

original $-3\le x\le 10$
$\quad\;\; -7 \qquad -7$
$-10\le x\le 3$

original $y\le 22$
$\quad +10$
$\boxed{y\le 32}$

Recognizing shifts of other, simpler functions can help us identify prominent characteristics and compare them. The location of turning points is especially helpful.

***Exercise* #4:** Given the quadratic function $f(x)=(x-4)^2-5$ answer the following questions.

(a) How has the simple quadratic $y=x^2$ been shifted to produce the graph of $f(x)$?

right 4

down 5

$y=(x)^2$

$y=(x-4)^2-5$

(b) Given that $y=x^2$ has a turning point at the origin, $(0,0)$, where must the turning point of f lie?

x y

$(0,0)$

+4 −5

$(4,-5)$

(c) Sketch f below and give the domain interval over which f is increasing.

(d) Which has a lower minimum value, the function f or the function $g(x)=|x-6|-10$? Explain your choice.

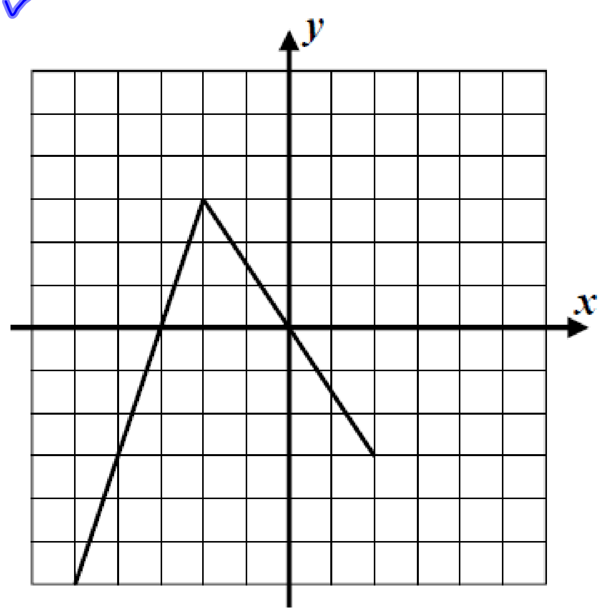
One of the hardest things for students to grasp is the horizontal shift, which appears to work opposite of what we would expect. Let's take a look at a shift that is purely horizontal.

***Exercise* #5:** The graph of $f(x)$ is shown below. The function $g(x)$ is defined by $g(x)=f(x-2)$.

(a) Show that $x=-1$ and $x=2$ are zeroes of the function g.

$g(-1)=f(-1-2)=f(-3)=0$ ✓

$g(2)=f(2-2)=f(0)=0$



(b) Evaluate each of the following using the definition of g and then create a plot of g on the same set axes.

$g(-3)=$ $g(0)=$ $g(4)=$

6) $h(t) = -4.9(t-\underline{4})^2 + \underline{153}$

Vertex form of Parabola

vertex: $(4, 153)$